

## TAPE CARRIER PACKAGE STRUCTURE WITH DUMMY PADS AND DUMMY LEADS FOR PACKAGE REINFORCEMENT

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention:

5 This invention relates to integrated circuit packaging technology, and more particularly, to a tape carrier package (TCP) structure with dummy pads and dummy leads for reinforcement of the package construction.

#### 2. Description of Related Art:

TCP (Tape Carrier Package) is an advanced type of integrated circuit packaging  
10 technology which is characterized in the use of a tape carrier, rather than a leadframe or a substrate, as the chip-mounting base, and also in the use of TAB (Tape Automated Bonding) technology to implement the overall packaging process. The tape carrier is typically formed with a device hole for accommodating the packaged semiconductor chip, and a plurality of inner leads bonded to the I/O pads of the packaged semiconductor chip to serve as external  
15 connecting means for the packaged semiconductor chip. A conventional TCP structure is illustratively depicted in the following with reference to FIGs. 1A-1D.

Referring to FIG. 1A, the conventional TCP structure is used to pack a semiconductor chip 110 having a plurality of I/O pads 111 arranged along the four sides thereof (note that FIGs. 1A-1C are simplified to show only a small number of bond pads and those  
20 parts that are related to the invention for demonstration purpose; the actual circuit layout of the TCP structure may be much more complex).

By the conventional TCP technology, however, no I/O pads are arranged on the four corners 110a, 110b, 110c, 110d of the semiconductor chip 110 (the four corners 110a, 110b, 110c, 110d are indicated by the dotted circles in FIG. 1A).

25 Referring further to FIG. 1B, the conventional TCP structure is constructed on a tape carrier 120, such as a ~~TAB~~ tape, which is formed with a centrally-located device hole

Referring further to FIG. 1B, the semiconductor chip 110 of FIG. 1A is to be mounted on a tape carrier 120, such as a TAB tape, which is formed with a centrally-located device hole 120a and is predefined with a plurality of lead-bonding areas 121 surrounding the device hole 120a (the areas indicated by the dotted rectangular boxes in FIG. 1B)

5 Referring further to FIG. 1C, during assembly, the first step is to mount the semiconductor chip 110 of FIG. 1A in the device hole 120a of the tape carrier 120 of FIG. 1B. As the semiconductor chip 110 is mounted in position, an ILB (Inner Lead Bonding) process is performed to bond a set of electrically-conductive inner leads 130 between the respective I/O pads 111 on the semiconductor chip 110 and the lead-bonding areas 121 on the tape carrier 120 to serve as external connecting means for the packaged semiconductor chip 110.

10 Referring further to FIG. 1D, in the next step, an encapsulation process is performed to dispense an encapsulation material, such as resin, through the gaps between the inner leads 130 into the device hole 120a so as to form an encapsulation body 140 to encapsulate the semiconductor chip 110.

15 In practical realization, however, the foregoing conventional TCP technology has the following drawbacks.

First, since the four corners 110a, 110b, 110c, 110d of the semiconductor chip 110 are provided with no bond pads and unconnected to any leads, these four corners 110a, 110b, 110c, 110d of the semiconductor chip 110 would be nearly unsupported. As a result, during the ILB process, it would easily cause cracking of the inner leads 130. In addition, during the movement of the tape carrier 120, it would easily cause the package construction to be subjected to deformation.

20 Second, during the potting process, since the corner-situated lead gap width (denoted by  $W$  in FIG. 1B) is considerably greater than the pitch of the side-situated inner leads 130 (denoted by  $P$  in FIG. 1B), it would cause the potting of the encapsulation material through these inner leads 130 during the encapsulation process to be unevenly distributed to the back side of the semiconductor chip 110, which would easily cause undesired forming of

sub 927 140 would be easily subjected to popcorn effect and delamination, thus degrading the quality and reliability of the finished TCP product.

### SUMMARY OF THE INVENTION

5 It is therefore an objective of this invention to provide an improved TCP technology which allows the corners of the packaged semiconductor chip to be firmly supported.

It is another objective of this invention to provide an improved TCP technology which allows the encapsulation material to be substantially evenly distributed to the back side of the packaged semiconductor chip, so as to allow the resulted encapsulation body to  
10 be substantially free of voids for prevention of undesired popcorn effect and delamination.

It is still another objective of this invention to provide an improved TCP technology which would prevent the package construction from being deformed during movement of the tape carrier.

In accordance with the foregoing and other objectives, the invention proposes an  
15 improved TCP structure.

Broadly recited, the TCP structure of the invention comprises the following constituent components: (a) a semiconductor chip having: (a1) a plurality of I/O pads arranged along the sides thereof; and (a2) a plurality of dummy pads arranged on the corners thereof; (b) a tape carrier having a device hole and a plurality of side-situated lead-bonding areas and  
20 corner-situated lead-bonding areas surrounding the device hole; (c) a set of inner leads, including: (c1) a group of I/O leads, which are bonded between the respective I/O pads on the semiconductor chip and the side-situated lead-bonding areas on the tape carrier; and (c2) a group of dummy leads, which are bonded between the respective dummy pads on the semiconductor chip and the corner-situated lead-bonding areas on the tape carrier.

25 During assembly, since dummy leads are bonded between the dummy pads and the corner-situated lead-bonding areas, the corners of the semiconductor chip can be firmly supported in addition to the lateral support of the semiconductor chip by the functional I/O

leads, thus reinforcing the package construction. During the inner-lead bonding (ILB) process, such reinforcement can help prevent the cracking of any of the I/O leads. Moreover, during encapsulation process, since the provision of the dummy leads can help reduce the lead gap width at the four corners of the device hole, it can help the encapsulation material to be more evenly distributed to the back side of the semiconductor chip, thus preventing the undesired forming of voids in the resulted encapsulation body, making the resulted encapsulation body less likely to be subjected to popcorn effect and delamination. In addition, it can help provide a uniform package height (UPH) to the overall package construction. These advantages allow the finished TCP product to be more assured in quality and reliability than prior art.

#### BRIEF DESCRIPTION OF DRAWINGS

The invention can be more fully understood by reading the following detailed description of the preferred embodiments, with reference made to the accompanying drawings, wherein:

FIG. 1A (PRIOR ART) shows a schematic top view of a conventional semiconductor chip;

FIG. 1B (PRIOR ART) shows a schematic top view of an individual TCP unit for packaging the semiconductor chip of FIG. 1A;

FIG. 1C (PRIOR ART) shows a schematic cross-sectional view of the TCP construction of FIG. 1C after being encapsulated;

FIG. 2A shows a schematic top view of a semiconductor chip with dummy pads according to the invention;

FIG. 2B shows a schematic top view of an individual TCP unit for packaging the semiconductor chip of FIG. 2A according to the invention.

## DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

A preferred embodiment of the improved TCP structure according to the invention is disclosed in full details in the following with reference to FIGs. 2A-2B.

Referring to FIG. 2A, the improved TCP structure according to the invention is used to pack a semiconductor chip **210** having a plurality of functional I/O pads **211** arranged along the four sides thereof. It is an important aspect of the invention that the semiconductor chip **210** is further formed with a plurality of non-functional dummy pads **212** on the four corners **210a**, **210b**, **210c**, **210d** thereof (note that FIGs. 2A-2B are simplified to show only a small number of I/O pads and dummy pads and those parts that are related to the invention; the actual circuit layout of the TCP structure may be much more complex).

In this embodiment, for example, the semiconductor chip **210** is an LCD (Liquid Crystal Display) driver chip; and the I/O pads **211** and the dummy pads **212** are made of aluminum. However, broadly recited, the semiconductor chip **210** can be any of various other types of semiconductor chips, while the I/O pads **211** and the dummy pads **212** can be made of any of various other suitable electrically-conductive materials.

Referring further to FIG. 2B, the TCP structure of the invention is constructed on a tape carrier **220** having a centrally-located device hole **220a** and predefined with a plurality of side-situated lead-bonding areas **221** along the four sides of the device hole **220a** and a plurality of corner-situated lead-bonding areas **222** on the corners of the device hole **220a**. The side-situated lead-bonding areas **221** are pre-bonded with a first group of inner leads **231** serving as I/O leads, while the corner-situated lead-bonding areas **222** are pre-bonded with a second group of inner leads **232** serving as dummy leads.

During assembly, the semiconductor chip **210** of FIG. 2A is mounted in the device hole **220a** of the tape carrier **220** of FIG. 2B. As the semiconductor chip **210** is mounted in position, an ILB (Inner Lead Bonding) process is performed to bond the I/O leads **231** to the

functional I/O pads **211** on the semiconductor **210** and meanwhile bond the dummy leads **232** to the non-functional dummy pads **212**.

Preferably, the dummy leads **232** are spaced at the same pitch as the I/O leads **231**, so that the pitch of the total set of the I/O leads **231** and the dummy leads **232** can be substantially equally spaced. This lead arrangement scheme can help facilitate the subsequent potting of encapsulation material through these I/O leads **231** and dummy leads **232** to be evenly distributed to the back side of the semiconductor chip **210**, thereby preventing the undesired forming of voids in the resulted encapsulation body (not shown), so that the resulted encapsulation body (not shown) would be less likely subjected to popcorn effect and delamination.

The bonding of the dummy leads **232** between the dummy pads **212** and the corner-situated lead-bonding areas **222** can help provide a firm support to the four corners **210a**, **210b**, **210c**, **210d** of the semiconductor chip **210** in addition to the lateral support of the semiconductor chip **210** by the I/O leads **231**, thereby reinforcing the mounting of the semiconductor chip **210** on the tape carrier **220**. During the ILB process, such reinforcement can help prevent the cracking of any of the I/O leads **231**.

Subsequently, an encapsulation process is performed by potting an encapsulation material, such as resin, through the gaps between the I/O leads **231** and the dummy leads **232** into the device hole **220a** so as to form an encapsulation body (not shown) to encapsulate the semiconductor chip **210**.

During the encapsulation process, since the provision of the dummy leads **232** can help reduce the lead gap width at the four corners of the device hole **220a**, it can help the encapsulation material to be more evenly distributed to the back side of the semiconductor chip **210**, thus preventing the undesired forming of voids in the resulted encapsulation body (not shown), making the resulted encapsulation body (not shown) less likely to be subjected to popcorn effect and delamination. Moreover, it can help provide a uniform package height (UPH) to the overall package construction.

During the movement of the tape carrier tape carrier 220, the total set of the I/O leads 231 and the dummy leads 232 can provide a firm support to the entirety of the semiconductor chip 210, so that it can help prevent the package construction from subjecting to warpage due to the stress from the movement.

5 In conclusion, the invention provides an improved TCP technology which is characterized in the provision of dummy pads and dummy leads to help reinforce the structural strength of the package construction. During assembly, since dummy leads are bonded between the dummy pads and the corner-situated lead-bonding areas, the corners of the semiconductor chip can be firmly supported in addition to the lateral support of the semiconductor chip by the functional I/O leads, thereby reinforcing the package construction. 10 During the inner-lead bonding (ILB) process, such reinforcement can help prevent the cracking of any of the I/O leads. Moreover, during encapsulation process, since the provision of the dummy leads can help reduce the lead gap width at the four corners of the device hole, it can help the encapsulation material to be more evenly distributed to the back side of the semiconductor chip, thus preventing the undesired forming of voids in the resulted encapsulation body, making the resulted encapsulation body less likely to be subjected to popcorn effect and delamination. In addition, it can help provide a uniform package height (UPH) to the overall package construction. These advantages allow the finished TCP product to be more assured in quality and reliability than prior art. 15

20 The invention has been described using exemplary preferred embodiments. However, it is to be understood that the scope of the invention is not limited to the disclosed embodiments. On the contrary, it is intended to cover various modifications and similar arrangements. The scope of the claims, therefore, should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.

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